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DE-A-2 058 766	GB-A-1 538 433
DE-A-2 543 019	GB-A-2 145 643
DE-A-2 638 323	US-A-2 543 344
FR-A-2 127 021	US-A-2 815 716
FR-A-2 475 425	US-A-3 676 963
FR-A-2 494 160	US-A-4 389 820

PATENTS ABSTRACTS OF JAPAN, vol. 8, no. 120 (M-300) 1557r, 6th June 1984; & JP - A - 59 24 961 (ISHIKAWAJIMA HARIMA JUKOGYO K.K.) 08-02-1984

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㉖ References cited:

PATENTS ABSTRACTS OF JAPAN, vol. 8, no. 83 (M-290) 1520r, 17th April 1984; & JP - A - 59 1166 (ISHIKAWAJIMA HARIMA JUKOGYO K.K.) 06-01-1984

PATENTS ABSTRACTS OF JAPAN, vol. 8, no. 83 (M-290) 1520r, 17th April 1984; & JP - A - 59 1165 (ISHIKAWAJIMA HARIMA JUKOGYO K.K.) 06-01-1984

PATENTS ABSTRACTS OF JAPAN, vol. 8, no. 2 (M-266) 1439r, 7th January 1984; & JP - A - 58 165 962 (ISHIKAWAJIMA HARIMA JUKOGYO K.K.) 01-10-1983

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Courier Press, Leamington Spa, England.

**EP 0 194 121 B1**

**EP 0 194 121 B1**

**⑤ References cited:**

**PATENTS ABSTRACTS OF JAPAN, vol. 7, no.  
203 (M-241) 1348r, 8th September 1983; & JP - A  
- 58 102 674 (ISHIKAWAJIMA HARIMA  
JUKOGYO K.K.) 18-06-1983**

## Description

The invention relates to blast cleaning, particularly but not exclusively of surfaces contaminated by radioactive substances.

The technology of web blast cleaning of surfaces of industrial and other plant, equipment and buildings using sand or other inorganic particulate materials as abrasants has been developed to a stage where considerable cleansing effect can be accomplished with a minimum of abrasant. When the contaminants to be removed are non-hazardous, this quantity of abrasant presents no significant problem; if this is of sand, for example, it is inexpensive and relatively easy to dispose of. However, when hazardous contaminants such as radioactive substances are involved and stringent precautions have to be taken in the disposal of the abrasant, even the minimum quantities referred to present considerable difficulties, and the present invention is concerned at least in part in reducing those difficulties.

According to the invention there is provided apparatus for removal of contaminants from surfaces with particles of ice carried in a fluid stream comprising means for producing particles of ice, auger means for introducing the particles into a fluid stream, and means for conveying the stream to the surface, characterised in that the apparatus further comprises transfer means arranged between the ice producing and auger means, said transfer means comprising a rotor arranged for rotation within a fixed cylindrical shell, the rotor having a plurality of radial vanes extending to the inner surface of the shell so that neighbouring vanes define with a portion of the shell a compartment which moves with the rotor from an upper position to a lower position, and the shell having first and second openings, the first opening being below the ice producing means whereby ice may fall from said ice producing means directly into successive compartments at the upper position, and said second opening being above the auger means whereby ice may fall from each successive compartment at the lower position directly into the auger means.

Each compartment may subsequently pass to a third position for discharging any ice not released to the auger means.

Embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, of which:

Fig. 1 is a schematic side elevation of an ice jet blast cleaning apparatus; and

Fig. 2 is a section on line II—II of Fig. 1.

Sand or other mineral particulate solids have conventionally been used in blast cleaning, including web blast cleaning, and the problems of dust and of the removal of the used abrasant have been accepted hitherto as unavoidable and quite acceptable in view of the relative cheapness of the material. Indeed the disposal of the spent sand presents no significant difficulties when the cleaning is of surfaces contaminated with non-hazardous materials, but where extremely

hazardous materials are concerned as in the refurbishing of nuclear installations, for example, the question of the disposal of the abrasant becomes more serious because during the cleaning operation the contaminants are removed from the original surfaces and become admixed with the abrasant. In the circumstances where radioactive materials are concerned, the contaminated abrasant has to be handled with extreme care and disposed of under strictly controlled conditions. The difficulty and expense of such disposal completely overrides the convenience and cheapness of sand as abrasant.

It has now been discovered that, with a suitable adaptation of the conventional blast cleaning equipment, hard ice particles may be used as abrasant in dry and wet blast cleaning with the considerable advantage that the spent abrasant will eventually melt and the contaminants may then be separated by filtration so that the resultant and relatively harmless filtrate may be readily disposed of.

Apparatus for use in connection with the method outlined above is shown in the figures and consists of a pressure hose 1 leading to a nozzle (not shown), to which hose compressed air, ice particles and optionally water are introduced to provide a fluid stream which issues from the nozzle in a jet.

The ice particles are produced by the use of a standard ice maker. This may be of drum and blade scraper configuration so as to produce particles of substantially regular size. As will be explained below, it is important that as far as possible the ice particles once formed shall not remain stationary and in contact with one another in case they begin to cohere under the influence of gravity. In an effort to maintain the separateness of the individual crystals, they are subjected to further cooling after production.

After cooling the particles are fed by gravity into a charging chamber via a chute 3. The charging chamber 2 consists of a cylindrical shell 4 and a rotor axially arranged within the shell and driven at controllable speed by suitable means such as an electric motor 5.

The rotor comprises a cylindrical core 6 from which a plurality of blades 7 project radially so as to contact the inner surface of the shell 4. According to requirements the blades may be fixed or spring loaded and the materials of construction of the blades and of the shell may be selected so that the blades form an effective pressure seal against the shell 4.

The shell 4 is provided with an inlet port 8 located below the chute 3 as well as outlet ports 9 and 10.

As the rotor is driven, in a clockwise direction as shown in Fig. 2, the blades 7 define, with the core 6 and the shell 4 a plurality of chambers which move cyclically between ports 8, 9 and 10.

The outlet opening 9 is arranged in alignment with the inlet opening 11 in the casing 12 of an auger 13. The auger is driven by a variable speed electric motor 14, and the auger screw 15 is so

constructed in relation to the direction of rotation of the motor 14 that material entering into the casing 12 will be forced thereby towards the hose 1.

Between the hose 1 and the auger 13 there are a series of pipe elements 16, 17 and 18. Pipe element 17 has a branch 19 which is connected to a source of high pressure air (not shown) such as a conventional compressor unit operating in a pressure range between 0.7 and 17.5 kg/cm<sup>2</sup> and with a flow rate of between 1.4 and 14 cubic metres per minute. An air cooling and drying unit 21 is introduced into the air line between the source and the branch 19.

Pipe section 18 similarly has a branch 20 which leads to a source of water at a pressure in the range 0.7 to 17.5 kg/cm<sup>2</sup> and a valve, not shown, capable of adjusting the rate of flow of water into the pipe 18 from zero to 54.5 litres per minute.

As shown in Fig. 1 the branch 19 is at an acute angle to the axis of the pipe element 17 so that air from the high pressure source is directed towards the hose 1. The flow of air from the branch towards the hose tends to cause a suction effect on the auger side of the pipe 17, and this effect is enhanced by providing pipe section 16 with an internal Venturi surface 21.

In use of the apparatus, ice particles produced by the ice maker and subsequently cooled are fed via the chute 3 so that they drop into one of the compartments in the charging chamber 2 defined between two blades 7. As the rotor is rotated at controlled speed within the shell 4 the chamber is closed by both blades 7 moving in sealed relationship with the inner surface of the shell until the leading blade passes the opening 9 when the ice particles, or some of them, fall under gravity through the opening 11 in the casing 12 of the auger 13.

The auger is being driven by the motor 14 and the ice particles are conveyed thereby towards the pipe element 16. During this period compressed, cooled and dried air is being introduced into the pipe element 17 via the branch 19 towards the hose 1, and the pitot effect of the air flow is such that, urged also by the auger 13, the ice particles are drawn into the air stream. Within the pipe element 18 the air stream loaded with ice particles is mixed as required with water which has also been suitably cooled and as required mixed with antifreeze or cleanser, for clearing the hose 1, and corrosion inhibitor.

The high pressure mixture of air, ice particles and optionally water is conveyed along the hose 1 to the nozzle whence it is discharged at the surface to be cleansed of its contamination. Provided that due precautions have been made to preserve the low temperature of the ice particles, such as by suitable lagging of the auger and pipe elements and hose, the particles reaching the surface will be sufficiently hard and sharp and particularly by virtue of the air pressure will have sufficient kinetic energy as to dislodge contaminants from the surface in essentially the same way as does sand in a conventional blast

cleaning operation. Unlike sand, however, the ice particles will melt sooner or later so that the removal of the dislodged contaminants becomes relatively easily effected by filtration from the water.

It will be understood from the description of the charging chamber 2 that as each compartment defined by an adjacent pair of blades 7 moves away from the inlet opening 8, another such compartment takes its place so that while ever the rotor is turning and ice is being fed to the chute 3, a continuous supply of ice will be presented to the auger. If, in spite of the control of the speed of both the auger and of the rotor, ice is presented to the auger at a faster rate than it can advance towards the hose 1, so that a compartment still contains ice after it has passed the opening 9, the remaining ice is discharged from the opening 10 into chute 22. The material discharged from the chute 22 is conveniently returned to the ice making machine.

Again, if ice is produced by the ice making machine at a faster rate than can be accommodated by the passage of successive empty compartments under the chute 3, excess ice will be directed away from the charging chamber and returned again to the ice making machine rather than to interrupt the flow of ice through the chute which could result in the particles sticking together.

When sand is used as an abradant in blast cleaning dust from fine particles can cause a significant problem, and one of the objects of introducing water into the fluid stream is to eliminate dust. It is likely in the operation of the present invention that dust will not present a problem and it may not be necessary to introduce water, but the apparatus described provides the facility for introducing water if required. Whilst the invention has a particular application in treating surfaces contaminated with radioactive substances, it is also of great value in the cleansing of buildings on account of the absence of dust, the reduced damage to the surface below the contaminant layer, and the fact that the spent particles of the abradant melt at ambient temperature and can readily be washed away down existing drains.

Whilst the invention has been described above as using ice as the abradant, it is to be understood that the ice could be replaced by other frozen liquid provided that the solid form is sufficiently abrasive and melts at ambient temperature.

As an alternative to propelling the particles in a fluid stream, they may be propelled mechanically, for example by the use of a centrifugal bladed-wheel blasting machine of known type. In this event it is preferable that a fluid stream be projected at the surface alongside or following the propelled particles in order to rinse away dislodged contaminants.

#### Claims

1. Apparatus for removal of contaminants from

surfaces with particles of ice carried in a fluid stream comprising means for producing particles of ice, auger means (13) for introducing the particles into a fluid stream, and means for conveying the stream to the surface, characterised in that the apparatus further comprises transfer means arranged between the ice producing and auger means, said transfer means comprising a rotor (6) arranged for rotation within a fixed cylindrical shell (14), the rotor having a plurality of radial vanes (7) extending to the inner surface of the shell so that neighbouring vanes define with a portion of the shell a compartment which moves with the rotor from an upper position to a lower position, and the shell having first (8) and second (9) openings, the first opening being below the ice producing means whereby ice may fall from said ice producing means directly into successive compartments at the upper position, and said second opening being above the auger means whereby ice may fall from each successive compartment at the lower position directly into the auger means.

2. Apparatus according to claim 1 wherein the shell of the transfer means has a third opening (10), after the second opening in respect of the direction of rotation of the rotor, said third opening providing for the discharge of ice from any compartment not totally emptied at the second opening.

3. Apparatus according to claim 1 or claim 2 wherein the transfer means forms a pressure seal between the ice producing and auger means.

4. Apparatus according to any one of the preceding claims wherein the fluid stream includes air, and the apparatus includes means for supplying air to the said fluid stream.

5. Apparatus according to claim 4 further including means (25) for cooling said air prior to supplying said air to said fluid stream.

6. Apparatus according to any one of the preceding claims wherein the means for conveying the stream to the surface includes a nozzle for supplying the stream at a pressure in the range from 0.7 to 17.5 kg/cm<sup>2</sup>.

7. Apparatus according to claim 6 wherein said nozzle supplies said fluid stream to the surface at a pressure in the range between 1.4 and 11.2 kg/cm<sup>2</sup>.

#### Patentansprüche

1. Vorrichtung zur Entfernung von Verunreinigungen von Oberflächen mittels Eispartikeln, die in einem Fluidstrom geführt werden, mit Vorrichtungen zur Erzeugung der Eispartikel, einer Fördervorrichtung (13) zum Einbringen der Partikel in einen Fluidstrom und Vorrichtungen zum Fördern des Stromes auf die Oberfläche, dadurch gekennzeichnet, daß die Vorrichtung weiterhin Übertragungsvorrichtungen aufweist, angeordnet zwischen der Eiserzeugungs- und Fördervorrichtung, wobei die Übertragungsvorrichtungen aus einem Rotor (6) besteht, der zur Drehung innerhalb eines festen zylindrischen Mantels (4) ange-

ordnet ist, wobei der Rotor eine Mehrzahl von radialen Rührschaufeln (7) aufweist, welche sich zur inneren Oberfläche des Mantels so erstrecken, daß benachbarte Rührschaufeln mit einem Teil des Mantels ein Abteil definieren, welches sich zusammen mit dem Rotor von einer oberen Position in eine untere Position bewegt, wobei der Mantel erste (8) und zweite (9) Öffnungen aufweist, wobei die erste Öffnung unterhalb der Eiserzeugungsvorrichtung ist, so daß Eis von der Eiserzeugungsvorrichtung direkt in aufeinanderfolgende Abteile in der oberen Position fallen kann und wobei die zweite Öffnung oberhalb der Fördervorrichtung ist, wodurch Eis von den aufeinanderfolgenden Abteilen in der unteren Position direkt in die Fördervorrichtung fallen kann.

2. Vorrichtung nach Anspruch 1, wobei der Mantel der Übertragungsvorrichtungen eine dritte Öffnung (10) nach der zweiten Öffnung bezüglich der Drehrichtung des Rotors aufweist, wobei die dritte Öffnung zum Abgeben von Eis aus jeglichem Abteil dient, das an der zweiten Öffnung nicht völlig entleert wurde.

3. Vorrichtung nach Anspruch 1 oder 2, wobei die Übertragungsvorrichtungen eine Druckabdichtung zwischen der Eiserzeugungs- und Fördervorrichtung bilden.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei der Fluidstrom Luft beinhaltet und die Vorrichtungen zur Zufuhr von Luft in den Fluidstrom umfaßt.

5. Vorrichtung nach Anspruch 4, weiterhin mit Vorrichtungen (25) zum Kühlen der Luft vor dem Zuführen der Luft in der Fluidstrom.

6. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei die Vorrichtung zum Fördern des Stromes auf die Oberfläche eine Düse umfassen zum Fördern des Stroms mit einem Druck im Bereich von 0,7 bis 17,5 kg/cm<sup>2</sup>.

7. Vorrichtung nach Anspruch 6, wobei die Düse den Fluidstrom auf die Oberfläche mit einem Druck im Bereich zwischen 1,4 und 11,2 kg/cm<sup>2</sup> fördert.

#### Revendications

1. Appareil pour enlever des produits contaminants de surfaces au moyen de particules de glace entraînées par un courant de fluide comprenant des moyens pour produire les particules de glace, des moyens à vis d'Archimède (13) pour introduire les particules dans un courant de fluide et des moyens pour amener le courant vers la surface, caractérisé en ce que l'appareil comprend de plus des moyens de transfert entre les moyens de production de glace et les moyens à vis d'Archimède, lesdits moyens de transfert comprenant un rotor (6) prévu pour tourner dans un carter cylindrique fixe (14), le rotor comportant une pluralité de palettes radiales (7) qui vont jusqu'à la surface interne du carter de manière que des palettes voisines définissent avec une partie du carter un compartiment qui se déplace avec le rotor d'une position haute à une position basse, et le carter ayant des première (8) et

seconde (9) ouvertures, la première ouverture étant en dessous des moyens de production de glace de manière que la glace puisse directement tomber desdits moyens de production de glace dans les compartiments successifs en position haute et ladite seconde ouverture étant au-dessus des moyens à vis de manière que la glace puisse directement tomber de chaque compartiment successif en position basse dans les moyens à vis d'Archimède.

2. Appareil selon la revendication 1, dans lequel le carter des moyens de transfert a une troisième ouverture (10), après la seconde ouverture par rapport au sens de rotation du rotor, la troisième ouverture étant prévue pour décharger de la glace de n'importe quel compartiment non totalement vidé à la seconde ouverture.

3. Appareil selon la revendication 1 ou 2, dans lequel les moyens de transfert forment un joint à

pression entre les moyens de production de glace et les moyens à vis.

5 4. Appareil selon une des revendications précédentes, dans lequel le courant de fluide comprend de l'air et l'appareil comprend des moyens pour délivrer de l'air audit courant de fluide.

10 5. Appareil selon la revendication 4, comprenant un autre des moyens (25) pour refroidir ledit air avant de la délivrer audit courant de fluide.

15 6. Appareil selon une des revendications précédentes, dans lequel les moyens pour amener le courant vers la surface comprennent une lance pour délivrer le courant sous une pression comprise entre 0,7 et 17,5 kg/cm<sup>2</sup>.

7. Appareil selon la revendication 6, dans lequel ladite lance délivre ledit courant de fluide à la surface sous une pression comprise entre 1,4 et 11,2 kg/cm<sup>2</sup>.

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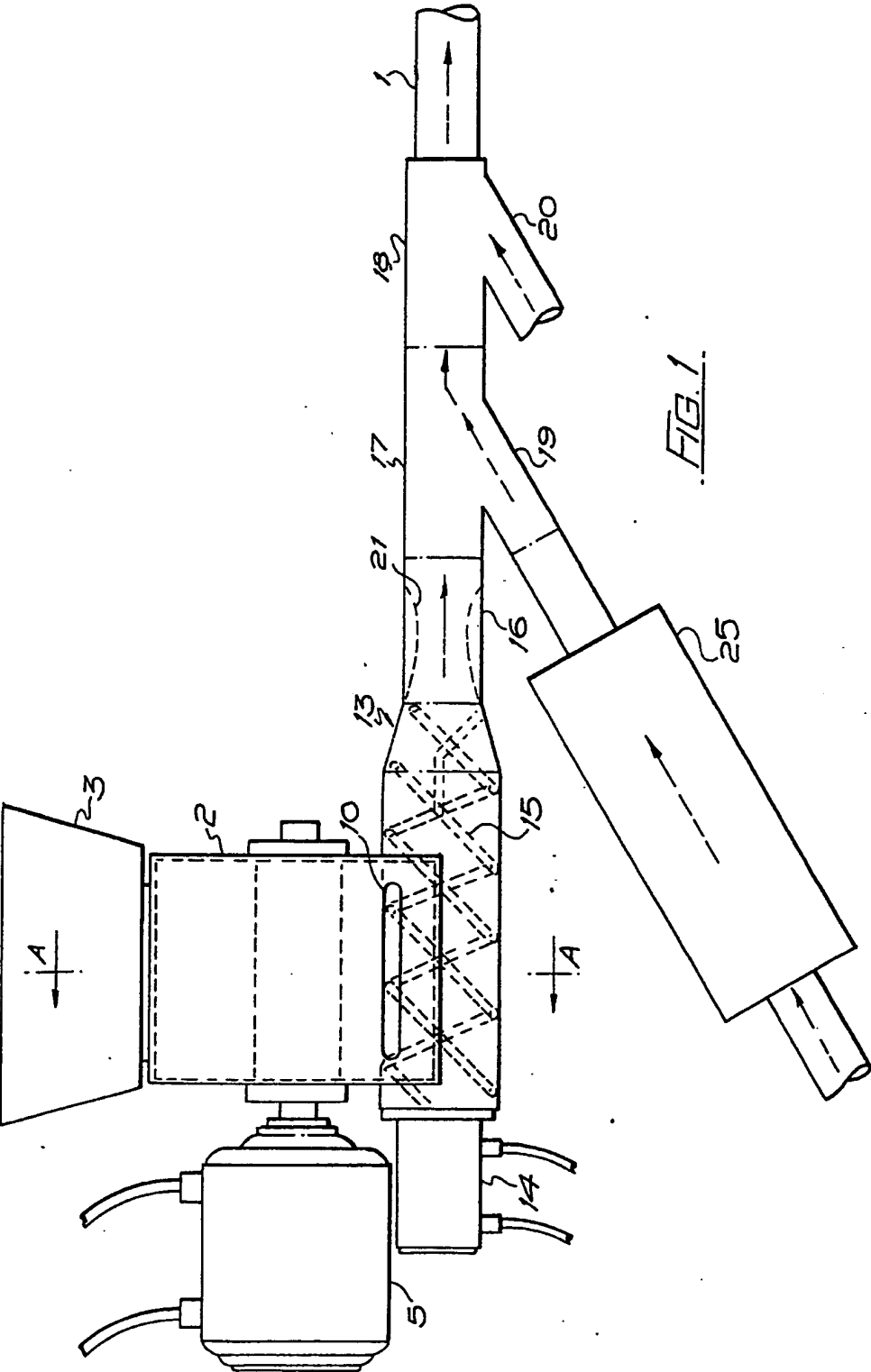
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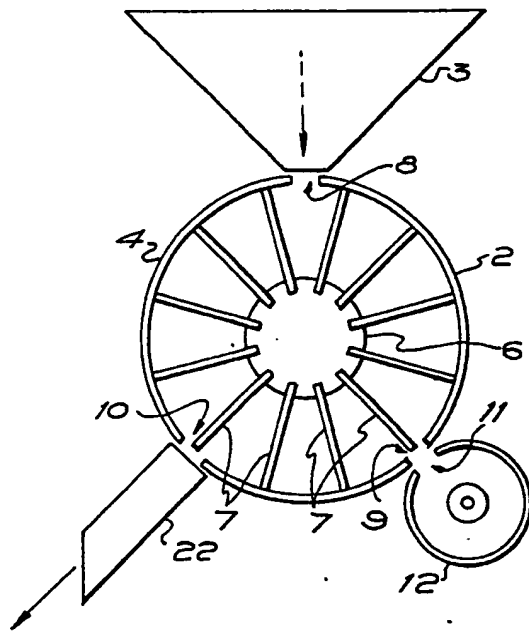


FIG. 2.

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